FARMERS' BULLETIN No. 1812

NATIVE AND ADAPTED GRASSES FOR CONSERVATION OF SOIL AND MOISTURE IN THE GREAT PLAINS AND WESTERN STATES

THE INFORMATION given in this bulletin should enable farmers in the Great Plains and Western States to select from the more common species of grasses some one or more suited to their needs. Common harvesting equipment and farm machinery can be adapted to the proper handling of native grasses. This brings the cost of such work within the means of most farmers.

The distribution maps and data presented in this bulletin are based on publications of the Department of Agriculture, particularly those of the Bureau of Plant Industry and the Forest Service, as well as on information gained in the field activities of the Soil Conservation Service. Federal and State agencies have cooperated at the several grass nurseries of the Soil Conservation Service and have assisted with this work.

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NATIVE AND ADAPTED GRASSES FOR CONSERVATION OF SOIL AND MOISTURE IN THE GREAT PLAINS AND WESTERN STATES

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INTRODUCTION

ON MOST FARMS in the Great Plains and Western States there are fields that should be revegetated, and the native grasses of the region, together with a few adapted introduced grasses, have proved most suitable for the purpose.

Only when the growth habits and the erosion-resistant properties of a grass are known can the best use be made of that grass, whether it be planted on range or pasture, on eroded abandoned areas of the farm, or in contour strips in cultivated fields.

Eroded and depleted lands are not all of one type; nor can they all be restored by the same treatment. In gullies, for instance, sod-forming grasses, such as vine-mesquite and Kentucky bluegrass, will catch and hold the soil particles carried in the run-off. In drainage-ways and terrace channels that carry excessive amounts of flood water during flash storms, grasses with vigorous, heavy root systems are needed that will resist the cutting effect of the water. The heavy rootstocks and densely massed roots of western wheatgrass make it an excellent plant for such use. These roots and the leafy top growth, bent down blade upon blade under the pressure of the water, make a mat through which water cannot cut its way to destroy the soil.

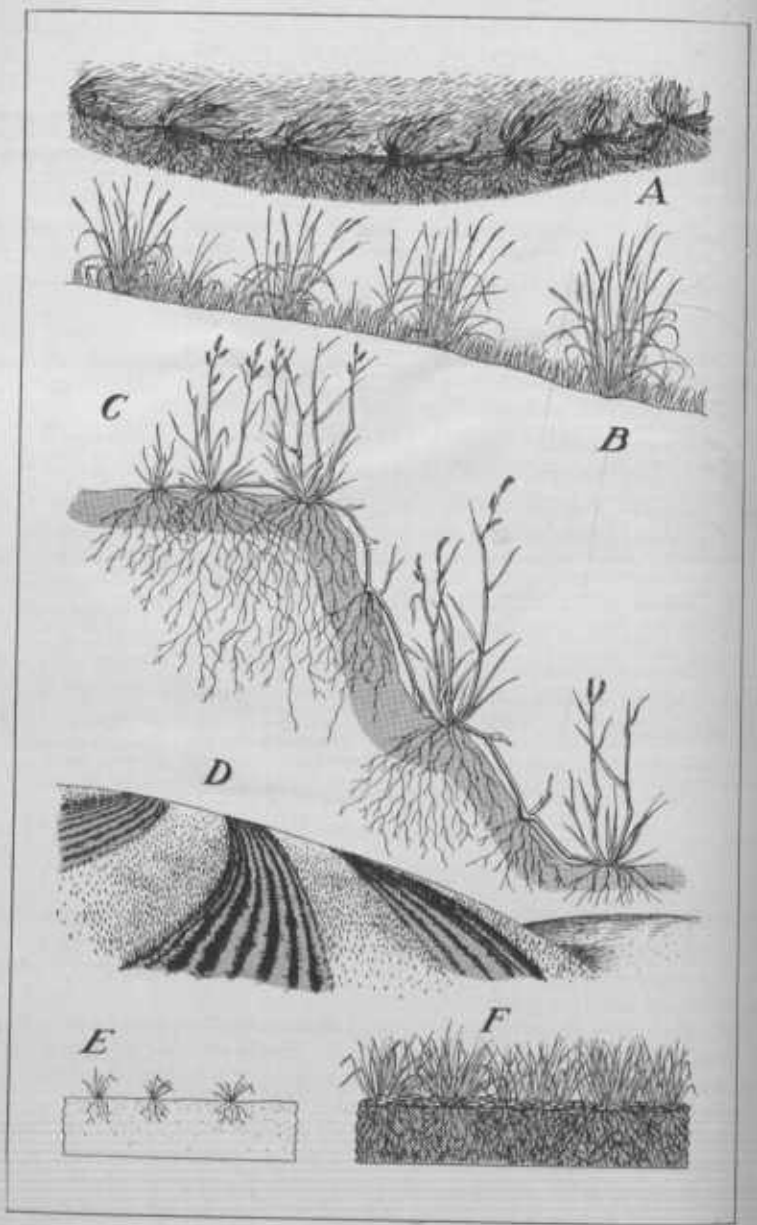


FIGURE 1.—*A*, The vigorous growth of rootstocks of western wheatgrass forms a dense sod highly resistant to the cutting of the water in drainageways, and the top growth forms a mat over which the water travels easily; *B*, side-oats grama produces volunteer seedlings that protect sloping lands with a permanent sod; *C*, vine-mesquite soon spreads a dense turf down the sides of a gully or stream bank by sending down new roots from the nodes on its stolons or runners; *D*, little bluestem is used widely in regular rotations in contour farming because of its high forage value and fibrous root system; *E*, infertile soil; *F*, accumulations of vegetative litter above ground and the decay of the fibrous grass roots in the soil improve fertility.

A grass, such as vine-mesquite or Bermuda grass, that has widely creeping stolons by which it can establish new plants may spread very rapidly and provide an effective vegetative cover in a pasture or on an eroded area; yet this same grass may be undesirable for planting in strips on cultivated fields, for it would interfere with cultivation by spreading or because of survival of the runners. Many of our so-called weedy grasses possess characteristics of high economic value if they can be properly controlled when grown in association with other plants. It is the costliness of proper control methods that limits the wider use of certain of these grasses.

The deep, extensive root systems of the grasses that can be used on cultivated fields add organic matter to the soil and improve the soil structure because of the thorough penetration of the fine hairlike roots that tend to bind the soil particles. The decay of the plant roots permits greater penetration of moisture and air, which adds to the general fertility and tilth of the soil. The top growth affords protection against the wind or the washing of the soil by rains. Plant residue remaining through the winter retains snow as it falls, thus serving as an effective agent in the conservation of snow moisture.

The grasses that are planted for pasture should give to the particular soil and slope on which they grow the protective cover needed. On the steeper slopes the sod-forming grasses are required. Yet it must not be forgotten that to best serve the purpose of soil conservation a plant should also be useful as forage or pasture.

Grasses, it is seen, have specialized uses in erosion control; they also have certain growth characteristics that determine what use can be made of them in conservation plantings (fig. 1). A plant that will grow on a sandy soil may not thrive on a heavy soil. A grass that provides adequate ground cover on gentle slopes may not protect the steeper lands; and one that thrives on south slopes may not survive on slopes that face the north. One condition may require a plant tolerant to shade; and another, a grass that can grow with little moisture. A grass excellent in controlling erosion on a stream bank, where moisture is plentiful, may fail on arid lands.

In considering the particular use to which a grass known to be excellent in erosion control can be put, it is necessary first to know where this grass will grow. If a grass that protects and enriches the soil grows on many different types of soils and under a wide range of climatic conditions it will rank high among the grasses used in conservation plantings. A small map indicating the major and minor areas of distribution has been prepared for each of the grasses discussed in this bulletin. These maps, each showing the natural distribution of a given grass, will serve as a guide in the choice of species that may be used successfully in artificial revegetation.

Since artificial revegetation requires planting, the seeding habits of grasses must be studied. Some grasses shatter their seed soon after it ripens, some are not reliable seed producers, and some grow only in scattered stands or in locations inaccessible to harvesting machinery. Other native stands produce seed of good quality that can be readily harvested.

The seeding habits of the grasses and procedures for producing seed under cultivation are discussed in the following descriptions of the different species, as are also satisfactory methods of collecting seed and establishing seedlings.

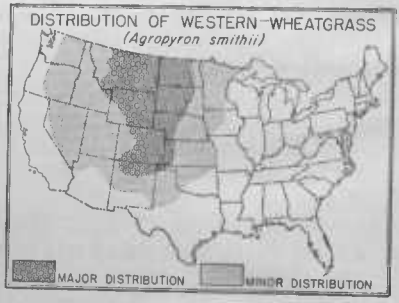
Information about special equipment and machinery used in the collection and cleaning of native grass seed in quantity is given in a separate section.

WHEATGRASS

Four of the wheatgrasses, all adapted to cold climates, find their greatest usefulness in the northern Great Plains, the intermountain region, and the higher elevations of the Rocky Mountain States. The fact that these grasses bind the soil, make good forage and ground cover, and are adapted to a wide range of soil and climatic conditions places them in the front rank of grasses useful in soil conservation.

WESTERN WHEATGRASS

Western wheatgrass (*Agropyron smithii*), a native perennial, is distributed generally throughout the United States, except in the more humid Southeastern States, but is more at home in the northern Great Plains. Pure stands of this grass are not uncommon, especially on the heavy gumbo soils of old lake beds. It is one of the native grasses that are used for both pasture and forage. Western wheatgrass has several outstanding characteristics that make it exceedingly valuable for use in erosion control. Its rapid growth and strongly creeping rootstocks (fig. 3) quickly produce both a ground cover and a heavy sod. By reason of its tall, grainlike growth (fig. 2), its seed can be harvested and cleaned easily and cheaply by the use of ordinary small-grain equipment. Further, the seed is relatively large and can therefore be sown easily and planted deep. Deep planting assures better germination and establishment where there is little moisture. The tenacious, soil-binding habit of this grass makes it especially suitable for reseeding abandoned farm lands. This is borne out by the fact that on abandoned farms that were not clean-cropped too long, good stands of western wheatgrass have developed from rootstocks carried over from the time when the land was first plowed.



Western wheatgrass is especially useful for sodding terrace outlets and channels as well as for seeding or sodding stream and reservoir banks as a protection against wave action. After the plants become established the long rootstocks and heavy root system effectively bind the soil by forming a dense sod and heavy vegetative cover. In gullies and terrace outlets, where the plants receive excess run-off water, the leafy top growth retains the soil particles carried in the run-off and so serves as an excellent de-silter.

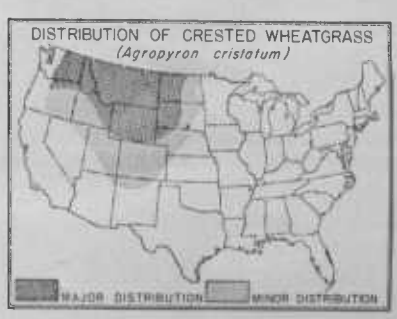
The production of viable seed from native stands is closely associated with favorable moisture and temperature during the early part of the growing season. As these conditions obtain throughout

most of the northern range of the species, this area is the leading source of seed. But since the wide distribution of native stands practically insures the possibility of a good seed crop each season at some place within its range it is not necessary to produce seed under cultivation. The Soil Conservation Service has collected from native stands several hundred thousand pounds of seed for use on demonstration project areas. These activities have so stimulated interest in this species that seed companies in the Great Plains are now listing for sale seed that has been largely collected by farmers from their own land.

Plantings in the grass nurseries of selected strains from several sources show wide differences in growth characteristics, including earliness, aggressiveness, and amount of vegetative growth and seed. Information obtained from field plantings shows that a seeding rate of 8 to 10 pounds an acre is satisfactory if plantings are made in rows suitable for cultivation, and a rate of 20 to 25 pounds if seed is drilled or broadcast.

CRESTED WHEATGRASS

Crested wheatgrass (*Agropyron cristatum;* fig. 4, *A*) was introduced from northern regions of the Union of Soviet Socialist Republics. This perennial bunch grass has proved to be particularly well-adapted to the soils and climate of the northern Great Plains and the intermountain region of the Pacific Northwest. It is a very good pasture and forage grass, is resistant to extreme drought and cold, has a deep, extensive root system, and reseeds readily. It is, therefore, especially suitable for reseeding in the dry, wind-erosion areas.

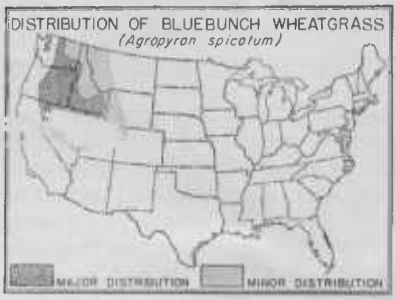


Superior strains of crested wheatgrass (fig. 4, *B*) developed by the plant-breeding stations in this country and Canada have been assembled in the grass nurseries of the Soil Conservation Service for further observation. Some of these are especially promising for erosion control. This grass has been found to be adapted to both row cultivation and closely drilled or broadcast seeding at a rate of 2 to 3 pounds per acre in single rows, 4 to 5 pounds in double rows, and 10 to 12 pounds in closely drilled or broadcast plantings.

In general, spring seeding has been found preferable to fall seeding. Late fall planting, however, is becoming rather common in the northern Great Plains, particularly on trashy, weedy land where the seedbed cannot be prepared before the time of seeding. Planting at this season is particularly advantageous in areas where wind erosion occurs, as it makes it unnecessary to lay the ground bare to the action of the wind. Also it aids in the retention of snow and the protection of the plants during the period of their early establishment.

BLUEBUNCH WHEATGRASS

Bluebunch wheatgrass (*Agropyron spicatum*), a native bunch grass, is widely distributed and extends from Alaska to California and into New Mexico and Montana. It reaches its maximum growth in the soils and climate of the Pacific Northwest and the intermountain region. Figure 5 shows selections of bluebunch wheatgrass at the Pullman, Wash., nursery and an individual plant.



At one time bluebunch wheatgrass was very plentiful, but the original stands have been damaged by overstocking and early spring grazing. Since this grass is very palatable and reproduces only from seed, deferred grazing, which permits the old plants to produce their seed crop before livestock trample them into the soil, is recommended as a means of insuring the maintenance of this grass.

BEARDLESS BLUEBUNCH WHEATGRASS

Beardless bluebunch wheatgrass (*Agropyron inerme*) has the same distribution as bluebunch wheatgrass (*A. spicatum*) but differs from it in that it has no awns. Both forms were once common throughout the intermountain region, and since they can be easily established from seed they should be used extensively in the revegetation of that region. Improved strains under observation at the Pullman, Wash., nursery that are superior in vegetative vigor and seed production are being increased for quantity distribution and use.

BUFFALO GRASS

Buffalo grass (*Buchloë dactyloides*), a native sod grass, is the most characteristic plant of the short-grass associations of the semiarid Great Plains (fig. 6, *A*, *B*). Although frequently found in mixtures with blue and hairy grama, it is the predominating grass of that region.

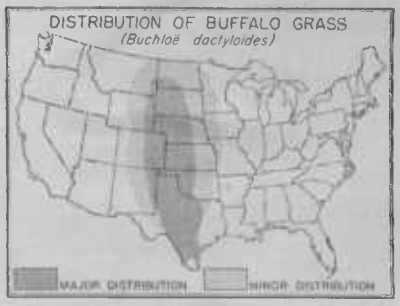
Buffalo grass makes a close, even turf, produces a large amount of nutritious forage, and forms a most effective erosion-resistant sod. In the southern Great Plains it ranks first among the native grasses for wind-erosion control, possessing all the characteristics desired for this purpose except that of producing heavy seed crops. Being very drought-resistant, it does well throughout the region except on very sandy soils. It spreads rapidly by means of stolons and withstands heavy grazing. Buffalo grass can be used to line terrace channels and outlets, to strip sod gullies, and to protect earth fills around ponds and reservoirs.

Buffalo grass has been successfully transplanted by using sod. Sod pieces 4 inches square and spaced at 4-foot intervals ordinarily give complete cover within two seasons. In resodding large areas a practical method of transplanting consists of the use of sheet-iron chutes in which pieces of sod are dropped in front of a wagon wheel (fig. 6, *C*). The pressure from the wheel pushes the pieces of sod firmly into the previously prepared seedbed. Vegetative plantings,

though very effective in establishing a stand, are costly on account of the large amount of hand labor required.

Extensive use of buffalo grass for erosion control has not been made, largely because of lack of sufficient seed. Not only does the plant set comparatively light seed crops, but its peculiar seeding habit has made the collection of seed very tedious and costly. Seed are borne in short-stalked burs that shatter readily, and once these burs have fallen to the ground they become entangled in the vegetative mass in such manner as to make their separation and collection very difficult. However, recognition of the value of this grass for conservation use has led to extra effort to obtain the seed. Special hand methods have proved satisfactory and have been supplemented by special equipment that facilitates the collection of seed in quantity.

In making hand collections heavy street brooms and ordinary flat-bottomed shovels and dustpans have been used in sweeping up the seed. The shattered seed burs are concentrated in low areas in riffles as the result of heavy rains. These depressions are sought out during dry weather and the seed swept up in convenient piles and then recleaned with a clipper mill. Another small-scale method of collecting the seed is to use converted lawn mowers with pan attachments on which bristle brushes have been substituted for the conventional rotating blades. Two pounds of burs per man-hour were collected in this way.



Several special types of motorized equipment to facilitate the collection of buffalo grass seed in quantity have been developed and tested by the Soil Conservation Service. The most successful of these machines was designed on the principle of a commercial vacuum cleaner. The suction developed from a rotating fan is used to pick up the seed burs from the mass of vegetation. Best success was had with a small portable machine of this same design having a small flexible nozzle that permitted collection of seed from the concentrated accumulations previously described. Weather conditions play a part in the successful use of this equipment. Heavy rains either carry away large amounts of seed or bury it in the soil in such a manner that its removal by suction is sometimes difficult.

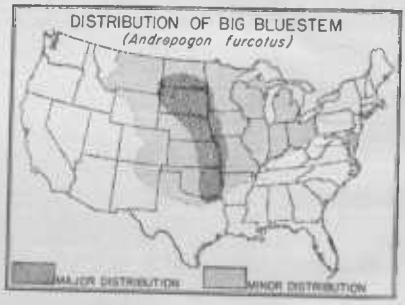
It has been found that buffalo grass seed will remain in good condition a long time after shattering, and germination studies indicate that old seed germinates much more readily than newly collected seed. Germination as high as 60 percent is not uncommon. Cutting tests indicate an approximate average of one and one-half seeds per bur. Trial plantings at the North Platte, Nebr., nursery of the Soil Conservation Service indicate that the ordinary corn planter can be used successfully in seeding this grass. Spot planting the buffalo grass burs with small grain, which serves as a row marker until the grass has become established, permits early cultivation of the grass seedlings.

BLUESTEM [1]

The bluestems comprise a very large group of grasses that is particularly well represented throughout the warmer regions of the world. The species that are of greatest usefulness in soil conservation practices grow in the central Great Plains.

BIG BLUESTEM

Big bluestem (*Andropogon furcatus*) is generally distributed throughout the eastern part of Oklahoma, Kansas, Nebraska, and South Dakota, but in the western part of these States, where climatic conditions are more severe, it is found only in scattered stands on the most favorable sites. The old saying that "big bluestem land is good corn-land" is indeed true, for much of the fine agricultural land of the Corn Belt was at one time covered with dense stands of this and associated tall prairie grasses. The plants are usually tall, leafy, and of a bunch habit of growth (fig. 7). They produce excellent pasture and hay. They also furnish effective protection against erosion, owing to the retention of the top growth and the deep penetration of the extensive root system.



During favorable seasons very satisfactory seed crops may be expected from native stands, but nursery plantings have produced higher yields of better quality seeds, especially plantings in which the mother plants were permitted ample space for development.

Information at hand regarding the proper rate, date, and method of seeding indicates that success in establishing stands of this grass depends largely upon the preparation of the seedbed and the depth of seeding. As a usual practice, the seedbed should be prepared as for ordinary grain crops and the seed planted not more than one-half inch deep. The fact that this is a native grass does not mean that it can be planted with any less care than the tame grasses. Rates of 6 to 8 pounds an acre, if it is seeded in rows suitable for cultivation, and 15 to 20 pounds, if seeded broadcast, have been found to give satisfactory stands.

This grass can be readily harvested by power strippers (p. 40), but recent field trials have indicated that the seed may be collected by using small-grain combine harvesters. Yields of 75 to 100 pounds an acre of field-run material averaging 25 percent pure seed by weight have been obtained in this manner.

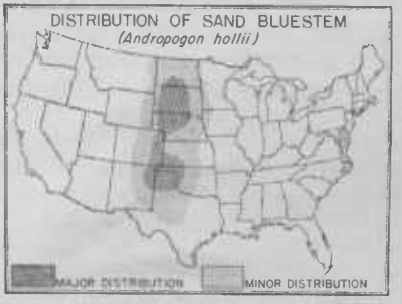
Big bluestem will no doubt be one of the first native grasses to be grown generally by farmers for the production of seed because the

[1] The common name given in Hitchcock's Manual of the Grasses of the United States for the Genus *Andropogon* is beardgrass. The three representatives of this genus mentioned in this bulletin are *Andropogon furcatus*, *A. Hallii*, and *A. scoparius*, for which Hitchcock's manual gives the common names blue-joint turkeyfoot, turkeyfoot, and prairie beard, respectively. In this bulletin, however, the common names "big bluestem," "sand bluestem," and "little bluestem" are used because of their wide acceptance throughout the regions where these grasses are native.

demand for the seed is increasing and farm machinery and methods can be used in its production.

SAND BLUESTEM

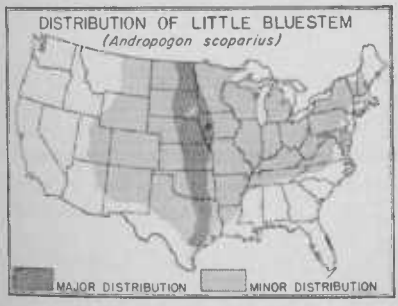
Sand bluestem (*Andropogon hallii*), like big bluestem, is considered excellent for forage and erosion control, but it is distinguishable from big bluestem by its heavy rootstocks and is especially adapted to very sandy soils. It is therefore one of the most desirable of the native grasses for use on sandy "blow soils." In the central Plains States it has been used with very good results in stabilizing certain soil types particularly susceptible to wind erosion. These plantings were made by using rootstocks from the mother plants or by seed. Seeding was most successful when the overripe, unthreshed hay was placed as a mat on the "blow soil" area. This old plant residue serves as a protective cover until the young seedlings become established.



The deep, extensive root system and the tall, stocky growth of this grass make it useful in the establishment of permanent contour strips as a protective measure against wind erosion, particularly on the more sandy soils of the Great Plains. If these strips were made a part of the regular sequence of crops in a rotation covering several years, they would serve as a ready source of the seed of sand bluestem. At the present time seed must be obtained by hand collections from the scattered natural stands.

LITTLE BLUESTEM

Little bluestem (*Andropogon scoparius*) is generally distributed throughout Nebraska, Kansas, Oklahoma, the blackland belt of south-central Texas, northern New Mexico, northern Arizona, Utah, and western Colorado. A perennial native bunch type, it occurs in dense stands where the soil is fertile and moisture plentiful but appears only in scattered clumps when growing on exposed, rocky, or arid sites. Principally because of its leafiness and vigorous root system, it is a very good erosion-control plant (fig. 8). Although it is highly palatable throughout most of its range, particularly during the early stages of growth, in the northern Great Plains it is considered only fair to poor as a pasture grass since there it soon becomes rather coarse and cattle do not graze it readily.



The seed of this grass can be harvested readily from native stands with power strippers or with small-grain combine harvesters. If collection is made with a stripper, the seed material should be threshed with an ordinary small-grain separator and cleaned with a clipper fanning mill. If harvested with combine harvester equipment, special care should be used in adjustments of air and screens to clean the seed without unnecessary waste.

Seed collected from native stands usually contains various amounts of associated species such as big bluestem, switchgrass, Indian grass, dropseed, and grama. Such seed mixtures are considered desirable for the reseeding done by the Soil Conservation Service because they represent the natural association of grasses that are adapted to the region where the work of revegetation is being done.

Excellent yields of high-quality seed have been obtained in the nurseries of the Soil Conservation Service from plantings in 6-inch paired rows spaced 30 inches apart to permit cultivation. If the seed is planted in this manner, a seeding rate of 6 to 8 pounds per acre is sufficient, but if it is drilled or broadcast on a field scale, 20 pounds is necessary.

A number of selections of little bluestem that possess desirable characteristics for use in conserving soil have been isolated by the United States Department of Agriculture and State experiment station plant breeders. Several of these developed by the Kansas Agricultural Experiment Station have outstanding merit because of uniformity in habit of growth and abundance of leafy foliage, and are now being made available for conservation planting.

Selected strains of both little bluestem and big bluestem, as well as of other native grasses, indicate wide differences in vegetative characteristics. Many of these selections show outstanding promise of superior qualities for use in conservation planting.

GRAMA

Five of the grama grasses are used extensively for revegetation of range lands. Characteristically, they are a part of the short-grass flora of the Great Plains and are a valuable constituent of the cover on the range land of that area.

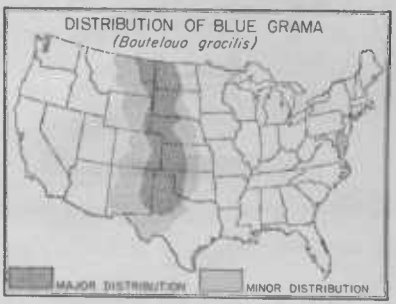
BLUE GRAMA

Blue grama (*Bouteloua gracilis*) occurs generally throughout the dry portions of the Great Plains, and in undisturbed soil it is commonly found associated with buffalo grass. In general, it is sod-forming in habit, which makes it especially desirable for use in erosion control. Its growth characteristics, however, vary considerably in different sections. For example, in its northern range, plants have a greater tendency to form sod than in its southern range, where they become taller, more vigorous, and assume more of a bunch habit.

Blue grama has a relatively shallow but very dense root system (fig. 10), and, although well adapted to heavy soils, it is by no means restricted to soils of this type. Because of its high palatability and

grazing capacity, as well as its wide soil and climatic adaptation, this grass is excellent as range forage and ranks high for use in range and pasture revegetation.

Seed of excellent quality has been produced at the grass nurseries, where the plantings were made in double 6-inch rows spaced 30 inches apart to permit cultivation. Under these conditions seed has been observed to show practically complete emergence within 48 hours after planting. Since plants grown from seed stock obtained from different localities show distinct differences in habit of growth, observations are being made with a view to finding the best sources of seed for revegetation. Figure 9 shows the marked differences in plants grown at Lincoln, Nebr., from seed collected in Oklahoma, Colorado, New Mexico, and Nebraska. The southern strains tend to mature later and to be more vigorous in comparison with those obtained from northern sources.



Field seeding practices vary widely, depending upon general environmental conditions and the purpose of the planting. In the wind-erosion area of the southern Great Plains precautions must be taken to give the newly emerged seedlings protection against wind damage by seeding in stubble or other protective crop residue. Good survival, especially in the central Great Plains, is closely related to the care used in making the seedings. For best results the seedbed needs to be carefully prepared, well firmed, and as free as possible of weeds previous to planting. Depth of seeding likewise bears a close relation to satisfactory emergence of the seedlings. As the seed is very small, it cannot be planted deep. Good stands have resulted from seedings broadcast at the rate of 5 to 8 pounds per acre, and from plantings made in rows at a rate proportionately less.

Both spring and fall seedings have been made throughout the range of this grass, with the result that very late fall planting of blue grama appears most likely to be generally successful in its northern range and spring seeding throughout the central Great Plains. Favorable moisture at the time of seeding is particularly desirable.

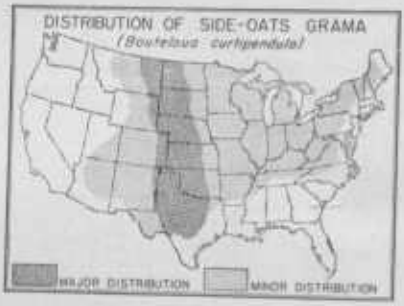
SIDE-OATS GRAMA

Side-oats grama (*Bouteloua curtipendula*) is the most widely distributed of all the gramas and is found generally throughout the United States east of the Rocky Mountains.

Although a perennial with scaly rootstocks, side-oats grama generally assumes a bunch habit of growth. It is found in association with other gramas and because of its leafiness is prized as a forage plant. The stems, however, are not palatable and often remain standing after the leafy foliage has been eaten by livestock. The seed heads

are distinctive and can be easily distinguished from those of other gramas because the numerous spikes are arranged bannerlike at one side of the stem (fig. 11). This gives the plant its common name, "side-oats" grama.

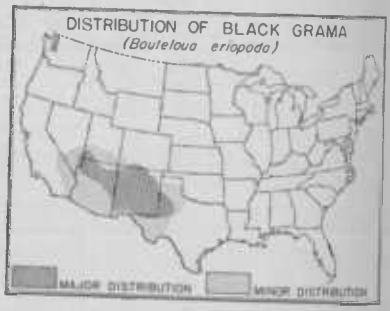
For seed production side-oats grama is one of the most promising native grasses that have been grown under cultivation in the nurseries, particularly because its upright growth habit facilitates harvesting. In rows spaced to permit cultivation, yields of 400 pounds per acre of seed have been obtained, and it is notable that the seed produced in this manner was of higher quality than that collected from native stands. Seed from these stands is usually low in viability, seldom giving more than 20-percent germination.



Experience gained from nursery plantings indicates the practicability of bringing this grass into wide use. Its leafy character, comparatively heavy stems, and strongly branching root system, combined with wide soil and climatic adaptations and ease of harvesting and seeding make it one of the most useful of our native grasses for general revegetation. It is considered especially suitable for replanting retired farm lands. Seeding at the rate of 20 pounds an acre if the seed is broadcast or drilled and 8 to 12 pounds if planted in rows has proved satisfactory.

BLACK GRAMA

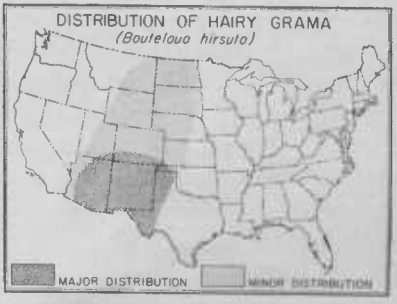
Black grama (*Bouteloua eriopoda*) is distributed more or less generally through southern New Mexico and Arizona and western Texas. It is one of the good forage grasses of the Southwest. The fact that it spreads by tillers and stolons gives it a high rank as a soil-binding plant and makes it very effective in erosion control.



Since it forms pure stands in certain favorable localities, areas that produce satisfactory seed crops can sometimes be found; but this grass does not develop viable seed consistently under natural conditions. In spite of this fact it is believed that the desirable qualities of black grama warrant special effort to bring it into general use in soil conservation. The development of methods of seed production is therefore being undertaken in the grass nurseries of the Soil Conservation Service in the Southwest.

HAIRY GRAMA

Hairy grama (*Bouteloua hirsuta*), a native perennial, is found in scattered stands throughout most of the Central and Rocky Mountain States. It reaches its maximum usefulness as a range plant in Arizona and New Mexico, where it occurs in mixtures with other grasses.



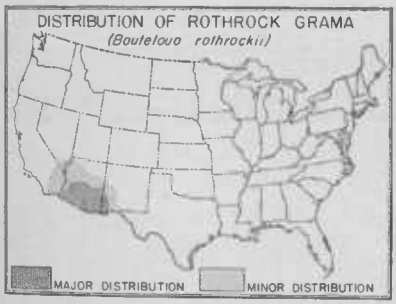
It is adapted to the same general soil and climatic conditions as blue grama and, like this grass, tends to form sod in the North and to assume a bunch habit of growth in the South. It is generally distinguished from blue grama by the coarse black hairs on the back of the spike.

The natural adaptation of this grass to unfavorable soils and sites should warrant its use in revegetation where others of the native grasses are likely to fail. Because hairy grama is found on rough, inaccessible ground and rarely in pure stands, the seed must be collected largely by hand. As this is expensive, the production of seed under cultivation may be advisable.

ROTHROCK GRAMA

Rothrock grama (*Bouteloua rothrockii*) occurs in the southern half of Arizona and southwestern New Mexico, where it often forms extensive pure stands.

It is an erratic, short-lived perennial, resembling blue grama except for the more numerous flower spikes. Ranchers consider it better than the annual gramas but not as valuable as the blue and hairy gramas, with which it is frequently associated.

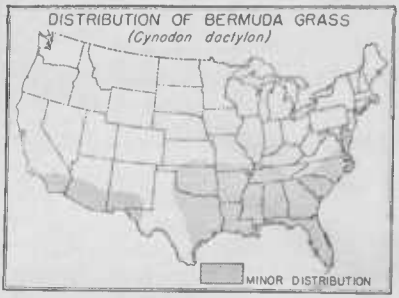


This grass does not withstand overgrazing, but during favorable periods the number of plants increases rapidly because of good seeding habits. With adequate protection it produces excellent cover on relatively sterile soils where but few other species will grow and for that reason especially is desirable for revegetation.

Seed of this grass should be produced under cultivation as the collection of seed from native stands is difficult and expensive.

BERMUDA GRASS

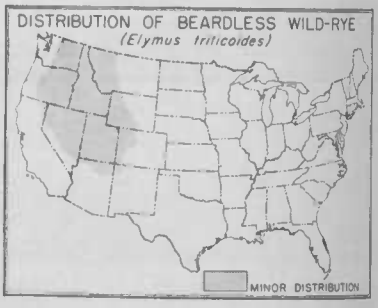
Bermuda grass (*Cynodon dactylon*), commonly called wire grass, is a perennial that was introduced from the warmer regions of the Old World. It is common throughout the Southern States and is found as far north as Maryland and Kansas, as well as in the warmer valleys of the Southwest. It produces underground rootstocks and creeping stems that take root readily at the nodes, a combination of growth characteristics that makes a very dense sod and gives the grass outstanding value for erosion control although its distribution is not wide because of its relatively high water requirement and lack of winter hardiness.



Bermuda grass used in the improvement and development of pasture lands also gives protection to the soil. In the South it is the most effective grass for use as a lining for terrace outlets and diversion ditches and as a protection for gully banks. After becoming well established, the sod serves not only as a good soil binder but also as an excellent de-silting agent. This grass is readily established from seed, stolons, or rootstocks.

WILD-RYE

Three of the wild-rye grasses are being used extensively in soil conservation operations. Medium palatability is characteristic of this group of grasses, but their excellent seed habits, heavy foliage, and relative ease of establishment place them among the most valuable grasses for use in revegetation.

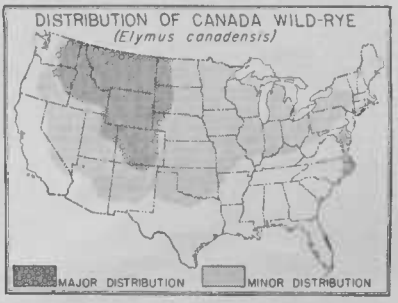


BEARDLESS WILD-RYE

Beardless wild-rye (*Elymus triticoides*) (fig. 12) is a heavy, sod-forming grass resembling western wheatgrass, with which it has frequently been confused. It is well adapted to the alkali and prairie soils and climate of the Pacific Northwest. Its extensive creeping rootstocks and colonizing habit of growth, its heavy foliage, and ability to produce good seed make it an excellent grass for erosion control. The plants tend to become coarse and woody when mature. Although this reduces their palatability, it greatly increases their usefulness as a ground cover.

CANADA WILD-RYE

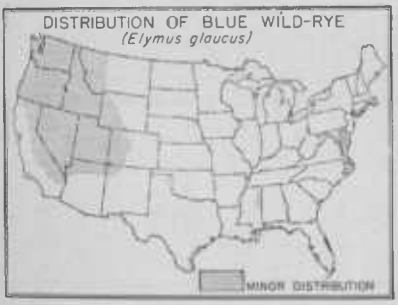
Canada wild-rye (*Elymus canadensis*) (fig. 13) is generally distributed throughout the cooler portions of the United States and finds its most suitable soils and climate in the northern Great Plains, in the Pacific Northwest, and at higher elevations in the Southwest. It is a vigorous, tall-growing perennial that produces an abundance of foliage and seed. As forage the grass is somewhat unpalatable, but this is offset by the very rapid germination and quick vegetative cover furnished by newly planted seedlings. Under heavy grazing this is one of the first species to disappear; but, if properly protected, it becomes quickly reestablished and supplies excellent protective ground cover.



Since this species does not form pure stands, it is necessary to collect seed by hand if it is to be obtained from natural stands. Seed of excellent quality and yield has been obtained from nursery plantings, and it appears essential for this species to be grown under cultivation to produce the required seed. Canada wild-rye has a place in conservation planting because of its ability to establish immediate vegetative cover.

BLUE WILD-RYE

Although found generally throughout the Western States, blue wild-rye (*Elymus glaucus*) (fig. 14) is most abundant in the Pacific Northwest, where it is considered valuable both for range forage and erosion control. It is much like Canada wild-rye in habit of growth, except that it has shorter awns and a somewhat finer foliage, and, as the name indicates, is covered with a whitish or bluish bloom.



In native stands this grass rarely grows alone, but is mixed with other grasses or weeds. The fact that it bears seed in abundance, establishes itself readily when given encouragement through proper protection, and produces a good ground cover gives it a high value for use in soil and moisture conservation. Observational plantings at the Pullman, Wash., nursery indicate great variation in this as well as the other ryegrasses. One of these selections that shows particular promise because of its dense ground cover, palatability, and ease of establishment is being increased for quantity use.

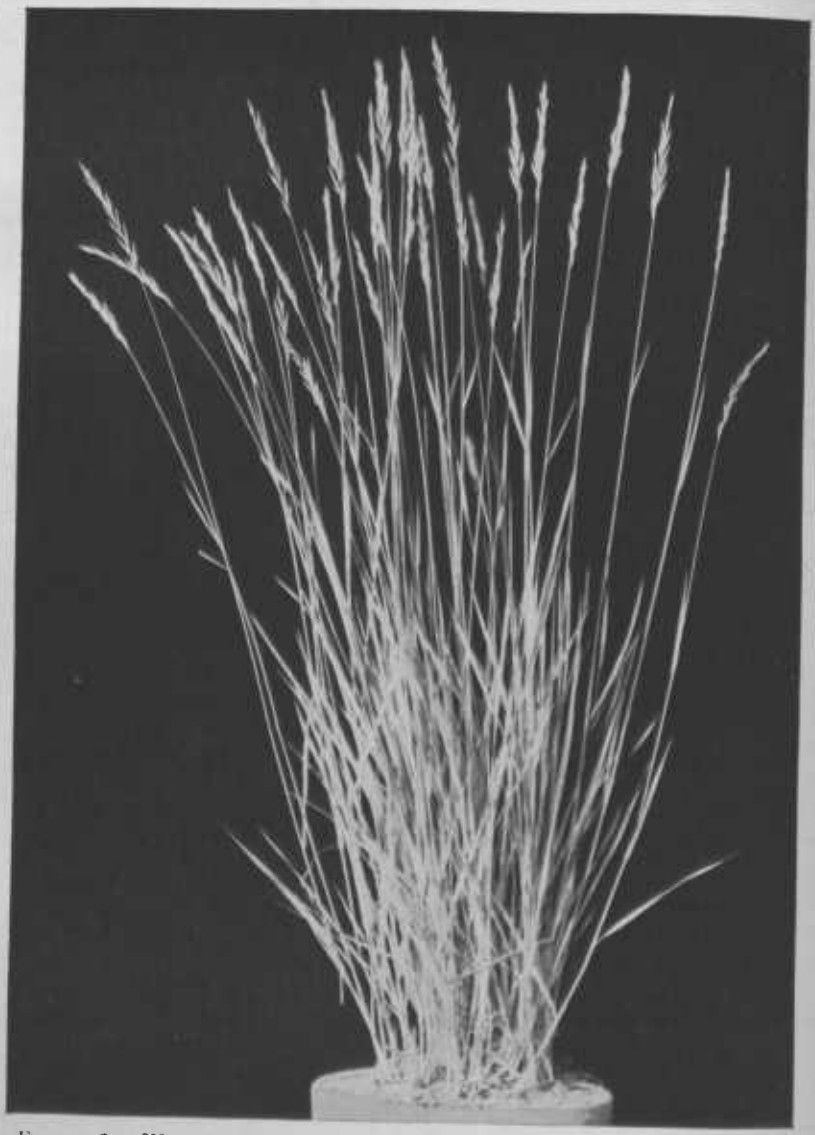


FIGURE 2.—Western wheatgrass produces a quick ground cover and a heavy sod over its wide range. Height, 30 to 36 inches.

FIGURE 3.—Western wheatgrass in a native stand, spreading by rootstocks. Present height, 12 to 18 inches.

FIGURE 4.—Crested wheatgrass: *A*, A drought-resistant, winter-hardy perennial that is particularly well adapted to the northern Great Plains. Height, 24 to 30 inches. *B*, Fairway strain. This is a valued forage plant because of its leafy early growth. It is widely used as a golf-course and lawn grass. Height, 12 to 18 inches.

FIGURE 5.—*A*, Selections of bluebunch wheatgrass grown for observation at the Pullman, Wash., grass nursery. Each selection shows distinctive growth characteristics. *B*, Extensive stands of this grass, a native bunch grass of the Pacific Northwest, covered the virgin prairies of the Palouse section.

FIGURE 6.—Buffalo grass is a native perennial sod former, characteristic of the short-grass vegetation of the semiarid Great Plains. *A*, An individual plant. *B*, The area at the left has been disk-plowed, as shown by the regularly recurring narrow strips of uncut sod. Blue grama plants are concentrated in these undisturbed strips. On the extreme right is undisturbed native sod. *C*, Blocks of freshly cut sod quickly establish a dense cover.

FIGURE 7.—Big bluestem, a native perennial bunch grass common in the mixed prairie vegetation of the central Great Plains. Height, 36 to 48 inches.

FIGURE 8.—Little bluestem, a native perennial bunch grass that grows over a wide range in the central Great Plains. Height, 24 to 30 inches.

FIGURE 9.—Observational plantings of blue grama at Lincoln, Nebr., produced from seed obtained in Oklahoma (*a*), Colorado (*b*), New Mexico (*c*), Nebraska (*d*), and New Mexico (*e*).

FIGURE 10.—Blue grama, a drought-resistant forage plant, widely distributed throughout the semiarid Great Plains. Height, 18 to 24 inches.

FIGURE 11.—Side-oats grama, a native perennial distributed generally throughout the Great Plains. This grass produces abundant seed and forage on dry sites. Height, 24 to 30 inches.

FIGURE 12.—Beardless wild-rye, a sod-forming grass that produces a good ground cover.

FIGURE 13.—Five strains of Canada wild-rye under observation at the Pullman, Wash., nursery. These strains, selected from native stands, show wide difference in growth characteristics.

FIGURE 14.—Blue wild-rye, a vigorous, rapid-growing native grass of the Pacific Northwest. Height, 36 to 48 inches.

FIGURE 15.—Tobosa grass covers vast areas of the semiarid Southwest. It is best adapted to heavy soils that are occasionally flooded. Height, 21 inches.

FIGURE 16.—Galleta grass thrives in the Southwest. Adaptation to areas of low rainfall is an important conservation characteristic. Height, 20 inches.

FIGURE 18.—A native stand of Tobosa grass.

FIGURE 17.—Curly mesquite, a native perennial of the semiarid Southwest, is an excellent conserver of soil and moisture. Height, 12 inches.

FIGURE 19.—Big bluegrass. Four strains growing in the Pullman, Wash., nursery, selected from native stands in the Pacific Northwest.

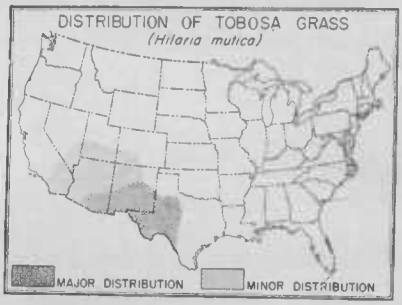
FIGURE 20.—Switchgrass, a native perennial, occurs plentifully throughout the Great Plains. This grass has excellent seeding habits and rapid, vigorous growth. Height, 36 to 48 inches.

HILARIA

Hilaria is a small genus of grasses especially adapted to the semiarid Southwest. These grasses have high value in the soil and moisture conservation practices of this region.

TOBOSA GRASS

Tobosa grass (*Hilaria mutica*) (fig. 15) is most extensive in southern Arizona and New Mexico and in western Texas. A strongly tufted perennial, it is confined chiefly to heavy soils, especially in swales that are occasionally subjected to floodwaters (fig. 18). Tobosa grass withstands grazing, but is relatively unpalatable after maturity because of the retention of dead leaves from one winter season to another. The new growth, however, supplies excellent forage before it becomes tough and woody. It is a good soil-binding plant, and its value in erosion control is augmented by the accumulated mass of dead foliage, which furnishes an excellent protective cover.

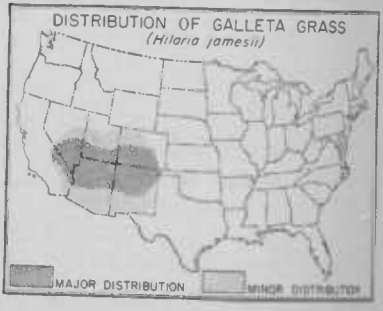


Seed can be harvested from native stands by the use of power strippers. The seed, like that of galleta grass, shatters readily and must be gathered at just the proper time if the seed is not to be lost.

GALLETA GRASS

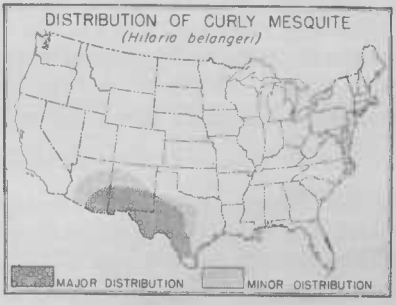
Galleta grass (*Hilaria jamesii*) (fig. 16) grows most abundantly in the western half of the Texas Panhandle, westward through Colorado, New Mexico, the northern half of Arizona and Nevada into California.

Galleta is a perennial grass with strong, scaly rootstocks and a deep, tenacious root system, which give it excellent soil-binding properties. It is one of the best forage grasses throughout its range, particularly in that it is resistant to heavy grazing and recovers rapidly when given protection from overgrazing. Seed is readily collected by machinery from native stands, but is subject to severe shattering, which necessitates watchfulness to prevent loss of the seed crop. Yields of 20 pounds per acre have been obtained. Since the percentage of filled seed is rather low, a seeding rate of about 10 pounds of uncleaned seed per acre is required. Under range conditions seed is sown broadcast and either covered lightly or left to come up naturally. Young seedlings are very drought-resistant and winter hardy.



CURLY MESQUITE

Curly mesquite (*Hilaria belangeri*) (fig. 17) is a range grass that grows rather generally throughout southern New Mexico and Arizona and occurs also in scattered stands over wider areas of the Southwest. It is sometimes confused with buffalo grass, with which it is frequently associated and which it resembles. Curly mesquite is a perennial that grows in loose tufts or clumps and reproduces both by seed and slender stolons.

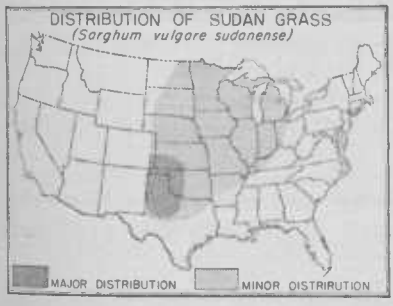


Its tufted stoloniferous habit, which gives it excellent soil-binding properties, its resistance to drought, and its aggressiveness under heavy grazing make it one of the best erosion-control grasses of the Southwest.

The plants are indeterminate in growth and produce seed rather sparingly throughout an extended period. There are two periods of maximum seed production, however, the first in early summer and the second after rains in early fall. Hand methods of collecting the seed have generally been used since the grass usually grows on rocky, steeply sloping land. But in certain localities the stands are dense enough and the land sufficiently level to permit satisfactory use of machinery. In view of this fact seed production under cultivation is necessary, and methods of growing the grass for this purpose are being studied at the nurseries.

SUDAN GRASS

Sudan grass (*Sorghum vulgare* var. *sudanense*) was introduced from north Africa in 1909. It resembles Johnson grass in general appearance, but, being an annual and lacking rootstocks, it does not become troublesome as a weed. Adapted to the same general soil and climatic conditions as sorghum, it has been grown with success practically throughout the United States. Extensive plantings have been made in the semiarid region of the Great Plains, especially in the "Dust Bowl," to assist in stabilizing soils susceptible to wind erosion. Sudan grass is one of the plants best suited to this purpose, as it germinates quickly and makes rapid, sturdy growth.



The usual procedure in establishing the grass is to blank-list the eroding field and leave the plant stubble in place at the end of the

season as a protective cover during the winter. Seedings the following spring are made in the plant residue, which serves to protect the young seedlings until they become well established.

Sudan grass is used extensively as a supplementary pasture and forage crop in important dairy centers. It also provides food and cover for birds. Seed is produced abundantly throughout the semiarid parts of the Great Plains. This grass is most useful in the agricultural economy of this region because of its extreme drought hardiness and adaptation to a wide variety of soils.

BLUEGRASS

The bluegrasses compose a large and economically important group, which is well represented in the United States. The more important of the native species are perennial and occur chiefly in the Pacific Northwest and Rocky Mountain regions.

BIG BLUEGRASS

Big bluegrass (*Poa ampla*) is the most important of a group of native bluegrasses common to the Western States. Although seldom found in dense stands, it is one of the most valuable range grasses of the intermountain region of the Pacific Northwest because of its heavy forage production, high palatability, and tendency to resume early spring and fall growth. This species is very drought-resistant. Because of its wide distribution, dense, extensive root system, heavy foliage, and adaptation to adverse sites and climates, it is one of the outstanding erosion-control grasses.

The seed is large and is ordinarily produced in abundance, but since the plant reproduces only by seed it is necessary to adopt range-management practices that will permit natural seeding to take place. Overgrazing and severe trampling are injurious to native stands of this grass, and, without proper protective grazing, a range will deteriorate rapidly.

Plants under observation at grass nurseries (fig. 19) show differences in seed, foliage, and growth characteristics, and marked improvement has been obtained by selection of plants having superior yield and value for erosion control.

KENTUCKY BLUEGRASS

Kentucky bluegrass (*Poa pratensis*) and Canada bluegrass (*P. compressa*) are introductions from the Old World that have become naturalized and are present generally in the cool, humid northern half of the United States east of the 99th meridian. These grasses are also found on the west slope of the Cascade Mountains of the Pacific Northwest and at higher elevations throughout the Rocky

Mountains wherever satisfactory temperature and moisture are present. It is significant to note that more than 20 years ago the Forest Service considered Kentucky bluegrass as one of the 10 most important grasses in Oregon and Washington.

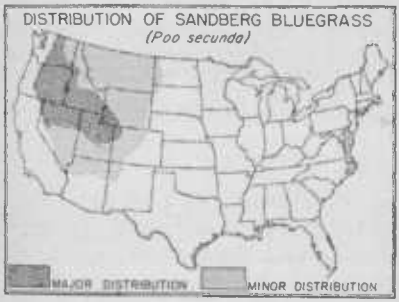
Both of these grasses form a dense, tough sod, capable of withstanding trampling by livestock. In the past it was thought that Kentucky bluegrass would grow only on limestone soils, but it is now understood that it is fertility rather than lime that is essential. Canada bluegrass is more drought-resistant and is adapted to less fertile soils than Kentucky bluegrass.

Both of these grasses are highly palatable and withstand grazing. This and their excellent seed and sod-forming habits make them very useful for erosion control. They can be adapted to terrace-channel and gully seedings if establishment is by seed and sod. The procedure followed in establishing these grasses by sodding is similar to that already described for some of the native grasses.

Seed of Kentucky bluegrass is grown commercially in the Ohio Valley and upper Mississippi Valley; that of Canada bluegrass is produced largely in Ontario and New York State.

SANDBERG BLUEGRASS

Sandberg bluegrass (*Poa secunda*) is common throughout the northern Great Plains, but the area of major distribution is in the intermountain region and Pacific Northwest. It is a perennial bunch grass that supplies a major part of the range forage during the early spring and remains dry and dormant the rest of the season. It is very drought-resistant and comes up and persists on semidesert and scabland where other native grasses have disappeared. This persistence is largely due to the fact that the plant is exceptionally deep-rooted and thus able to withstand trampling by livestock. Growth and seed production take place during the early season, when moisture conditions are favorable. The excess leafage produced at this time remains palatable throughout the season, and this plant therefore contributes to the carrying capacity of many of the ranges of the Northwest.



Sandberg bluegrass produces a fair amount of seed; with proper management the stand can be maintained indefinitely. Seeding trials made thus far under controlled conditions indicate that it is difficult to establish this grass from seed.

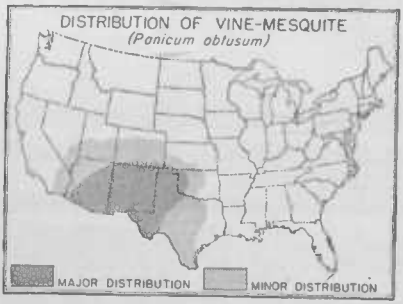
PANIC GRASSES

The panic grasses are very numerous and are found chiefly in the warmer regions of the world. This group is very well represented in the United States, but only two species are being used extensively in the conservation program.

VINE-MESQUITE

Vine-mesquite (*Panicum obtusum*) is found generally in western Texas, Arizona, New Mexico, and southern Colorado. It forms a characteristically viny growth and occurs more commonly on good soils that have more than the normal amount of moisture.

The creeping runners grow very rapidly. They take root at the nodes, anchoring themselves tightly to the ground, and produce new plants. They quickly form a dense soil-binding mat, which makes the vine-mesquite a particularly valuable erosion-control plant. It reproduces not only by creeping runners and by rootstocks, which transplant readily, but also by seed. But since it requires considerable moisture and does not thrive on all soil types, it finds its best use as lining for drainageways and as protective bank cover.



Successful vegetative plantings have been made by transplanting rootstocks or suitable pieces of sod. The greatest success has been reported when this work was done in early spring during periods when moisture and temperature were most favorable.

Seed of vine-mesquite has been harvested successfully with power strippers and also by cutting the grass as hay and threshing. But the seed collected from natural stands is usually of low quality and does not germinate well. During some years native stands are heavily infested with ergot, which further lowers the quality of the seed.

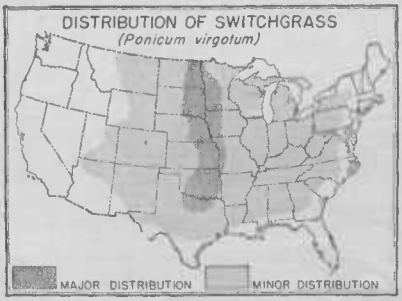
SWITCHGRASS

Switchgrass (*Panicum virgatum*) (fig. 20) is a native perennial that occurs widely throughout the United States but reaches its greatest usefulness in the Great Plains.

This grass develops extensive rootstocks and produces an abundance of leafy forage, which makes a hay of acceptable quality if cut at the proper stage of growth. If switchgrass is grazed, the excess foliage soon becomes harsh, woody, and unpalatable to livestock, although it continues to supply abundant ground cover. The old stems and leaves remain standing throughout the winter. They offer protection against wind and serve as a natural barrier to snow and soil drifting. This special quality, in addition to deep-rooting and vigorous rootstocks, makes this an outstanding grass for use in erosion control.

Selected strains grown for observation at the grass nurseries of the Soil Conservation Service show marked differences in resistance to grasshoppers and rust. Resistance to insects and disease makes it further dependable for conservation use.

Switchgrass is used in the northern Great Plains in planting contour strips as a protection against wind and water erosion. The old plant residue left in place provides a very effective snow trap and ground cover during the winter.



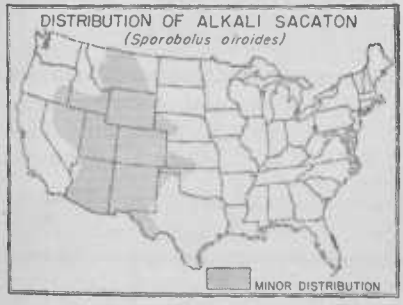
Seed has been satisfactorily collected from native stands by using power strippers, although under natural conditions the seed usually contains varying amounts of big bluestem, Indian grass, and other associated tall prairie grasses. Excellent yields of pure, good-quality seed also have been obtained at the nurseries when this grass was grown in rows spaced 30 inches apart to permit cultivation. When this grass was planted in rows seeding at the rate of 6 to 8 pounds per acre gave excellent stands, but 15 or 18 pounds was required when seed was broadcast or drilled.

DROPSEED

The dropseeds belong to a large group of grasses that receives its common name because of the promptness with which the seed is shed after ripening. Several of these grasses are adapted to the climatic and soil conditions of the Great Plains and the Southwest, where they can be used widely in erosion control.

ALKALI SACATON

Alkali sacaton (*Sporobolus airoides*) is very common in all States west of the Mississippi River and, as the name indicates, is especially resistant to alkali soils. It is a large perennial bunch grass, which produces a fair quality of hay if cut at the proper stage of development. If allowed to mature, the plants become woody and more or less unpalatable either for hay or grazing.



The seed is easily collected in quantity from native stands with power strippers or by threshing the stacked hay and can be used without further cleaning. Although seed of excellent quality has also been produced at the grass nurseries, where unusually heavy yields have been obtained, it is not necessary that seed of this grass be produced under cultivation, since

its general distribution insures a good seed crop every season somewhere within its range.

This native grass is very desirable for general use in revegetation, particularly on highly alkaline soils, because of its heavy foliage, deep root system, drought-resistant properties, and ease of seeding.

SAND DROPSEED

Sand dropseed (*Sporobolus cryptandrus*) is distributed generally throughout the United States, but is especially well adapted to climatic conditions in the States west of the Mississippi River. It is an important constituent of the native grasses of the Great Plains and, as the name "sand dropseed" indicates, is commonly found on sandy soils. It produces rather heavy forage that is fairly palatable to all classes of livestock, but care is necessary to avoid destroying the stand by overgrazing. This grass recovers rapidly, however, owing to its excellent seeding habits.

Sand dropseed is easily harvested by power strippers. Since the seeds shatter readily, the material obtained from the strippers is often clean enough to be seeded directly with farm equipment. Scarifying the seed makes good germination much less difficult to obtain.

Sand dropseed is among the first grasses to appear naturally on unused farm lands, and it provides effective cover until replaced by a more valuable crop. It is well adapted to seeding in mixture with other native grasses. Seeding at the rate of 2 pounds per acre has given a satisfactory cover.

NEEDLEGRASS

The needlegrasses are world-wide in distribution and are well represented in the native flora of the western United States.

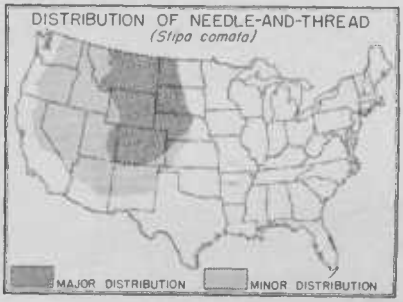
Although individual species differ widely in their relative usefulness for forage and erosion control, the group as a whole supplies abundant feed and vegetative cover in many of the principal range areas. Range men hold different opinions as to the value of some of these grasses, some saying that the heavily awned seed frequently cause serious harm to grazing animals.

The numerous grasses of this group are widely distributed and have the ability to produce vegetative cover under extremes of climate and widely different soils. Because of this wide adaptability these grasses are especially useful in soil and moisture conservation. Many of them are among the pioneer species that come naturally into retired farm lands, and, because of their drought hardiness and ability to withstand close grazing, they are among the last to disappear from a severely misused range.

As these grasses grow naturally in association with other more palatable grasses they may be seeded in mixtures for revegetation.

NEEDLE-AND-THREAD

Needle-and-thread (*Stipa comata*) is a leafy bunch grass and is commonly found throughout the Western States on dry sandy soils. It produces an abundance of forage, particularly during early spring and summer. Its common name refers to the long threadlike awns that form a characteristic seed head.



This grass is held in great esteem by some range men, although others feel it is more or less of a pest because of its heavy, sharp awns, which cause injury to grazing animals at certain seasons. In most regions a large amount of grazing is possible early in the season before the grass matures; and during some seasons very acceptable hay can be cut after the seed has shattered.

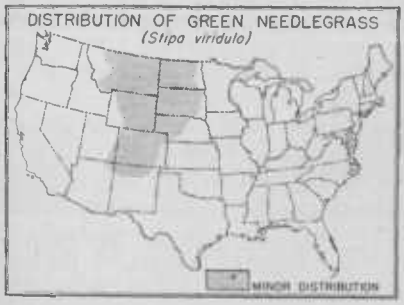
Seed of very good quality has been collected by power strippers from native stands of this grass. The heavy awns and sharp callus, however, make collecting and threshing operations rather difficult.

In field plantings of this grass best results have been obtained from mixed seedings.

GREEN NEEDLEGRASS

Green needlegrass (*Stipa viridula*) is a perennial bunch grass that is particularly useful on the ranges of the northern Great Plains.

It is considered an excellent forage grass chiefly because it begins growth early in the season and remains green for a long period. Although the species bears abundant awns they are short and slender and not as objectionable as in some of the other needlegrasses.



Seed of green needlegrass has been collected from native stands with power strippers; when obtained in this manner, the seed is usually mixed with that of other associated grasses.

Seed produced under cultivation has been excellent in yield and quality. Observational plantings, however, indicate wide differences in selections obtained from various sources, not only in yield of seed and forage but also in percentage of germination and growth habits.

Newly emerged seedlings of green needlegrass have been found to be resistant to drought and injury from sand cutting. This ability to withstand extremely unfavorable conditions during the period of establishment makes this species one of the most useful native grasses to include in seed mixtures used for revegetation.

SPECIAL EQUIPMENT USEFUL IN PLANTING NATIVE GRASSES

The extensive use of many of the stoloniferous or sod grasses in revegetation operations has called for special methods of planting. Both Bermuda grass and buffalo grass have been successfully handled by the method illustrated in figure 6, C. Establishment of these sod types appears to be dependent upon placing the stolons in firm contact with fresh soil, and it was most successful when the transplanting was done in early spring just preceding the growing period.

FIGURE 21.—Hand-operated native-grass seeder, constructed from ordinary crank-operated duster. This equipment can be used effectively on windy days and permits even seed distribution.

Seeding equipment now available for drilling grass seed is not well suited to the seeding of native species. Most native seed is fluffy and light and, therefore, cannot be fed evenly through present types of drills. A more fundamental difficulty concerns the depth of planting and method of covering. Most native grasses require a well-firmed seedbed and should not be covered more than ½ to 1 inch in depth. Many attempts have been made to design equipment to meet these requirements, but as yet no machine entirely satisfactory has been developed.

A hand seeder useful in seeding native grasses on contour furrows is illustrated in figure 21. This machine has been constructed by making a few changes in an ordinary crank duster, and by using an extension tube and spreader it is possible to make contour seedings on windy days.

The lister device illustrated in figure 22 has been used in certain parts of the Great Plains in making contour seedings of native grasses on abandoned farm lands. This machine has a distinct advantage in that the seeded area is left ridged after being seeded, and in regions of scant moisture this is a very important factor in determining the success or failure of the seeding operation. A cotton-type planting box equipped with a properly regulated shoe to control depth of planting and a suitable packer wheel makes this equipment very useful for seeding most of the grasses used in the central Great Plains.

FIGURE 22.—Special lister designed to plant native grass seed in contour furrows. This type of equipment is particularly useful in the semiarid parts of the Great Plains.

SPECIAL EQUIPMENT USED IN THE COLLECTION AND CLEANING OF NATIVE GRASSES

The wide use of grass for conservation of the soil has entailed the devising of methods of collecting, cleaning, and seeding native grass seed never before harvested. Farm machinery has been put to new uses, and new equipment has been designed.

GRASS KNIFE

A simple but very effective aid in the hand collection of certain of the native grasses is a curved knife with a 6-inch cutting blade that can be constructed from any scrap steel that will retain a good cutting edge when sharpened.

In using this knife laborers carry bags strapped to their waists or across their shoulders and place each handful of grass in the bag as it is cut. When the bag has been filled, the strap is loosened and attached to an empty bag. Hooks on the strap facilitate this exchange of containers.

The tool is especially adapted to collecting bunch grass in scattered stands. The amount of little bluestem seed each man harvested was increased from 125 to 200 pounds per 8-hour day when this grass knife was substituted for the knives previously used.

BLUEGRASS STRIPPER

The commercial revolving spike-cylinder seed stripper commonly used in harvesting cultivated grasses, particularly bluegrass and meadow fescue, has proved very satisfactory for use in the collection of many of the native grasses. Hooked in tandem, such a unit has

been used most effectively to collect blue grama seed on 25 to 30 acres in a normal working day.

POWER STRIPPERS

In collecting seed of the native grasses in quantity it is necessary to have equipment that will operate on the rough ground on which many of the grasses are found and collect the seed rapidly before it becomes overripe and shatters. Power strippers designed on the principle of the commercial spike-cylinder bluegrass stripper meet both these requirements.

The earliest of these power strippers (fig. 23, *A*) consisted of a revolving spiked cylinder and seed box mounted on a frame and carried on a truck chassis. The cylinder of this stripper was driven by chain and sprocket from the rear wheel of the truck chassis, with the steering gears inverted to permit the operator to drive the machine in reverse. Made up largely of used-car parts, the machine was crude in construction but surprisingly effective in increasing the output of seed per collecting unit. Such a machine was able to cover about 25 acres in an 8-hour day.

After this stripper was used for one season, several improvements were made that greatly added to its efficiency (fig. 23, *B*). The cylinder box was mounted in front of the truck in such a manner as to permit height adjustment from the car cab. The stripper proper is driven from the rear wheel of the truck by means of a sprocket wheel, chain, pulley, and belt arrangement. A commercial bluegrass stripper attached to the rear of the truck gives a total stripping swath of 13 feet. This unit also has the advantage of being readily detachable, which allows the truck to be used for other purposes.

Figure 23, *C* shows a modification of the original power stripper developed at the Tucson, Ariz., nursery being used to harvest Rothrock grama. Operated by side draft, this stripper is driven directly from the rear wheel of the truck, and a change of cylinder speed is made possible by means of a special gear. The cylinder, hopper box, and frame are of heavy, reinforced construction, and the stripper unit can be dismounted and attached to the truck as a trailer. One man can operate the machine.

GRAIN BINDERS AND MOWER BUNCHERS

Regular small-grain binder equipment can be used in harvesting the seed of some of the taller native grasses if the stands are dense or tall. If shattering is excessive the bundle-tying apparatus is removed in order to leave the cut grass in windrows for curing and subsequent threshing. Reapers have been used very satisfactorily in this same manner in collecting seed of some of the taller grasses.

The mower buncher, which has rather wide use in the handling of some of the commercial grasses and legumes, is more useful at the grass nurseries than under range conditions, where the natural stands are less suitable for such handling.

COMBINE HARVESTERS

Combine-harvester equipment can be used effectively in areas where the topography and type of grass permit satisfactory operation. Western wheatgrass was the first native grass to be harvested in

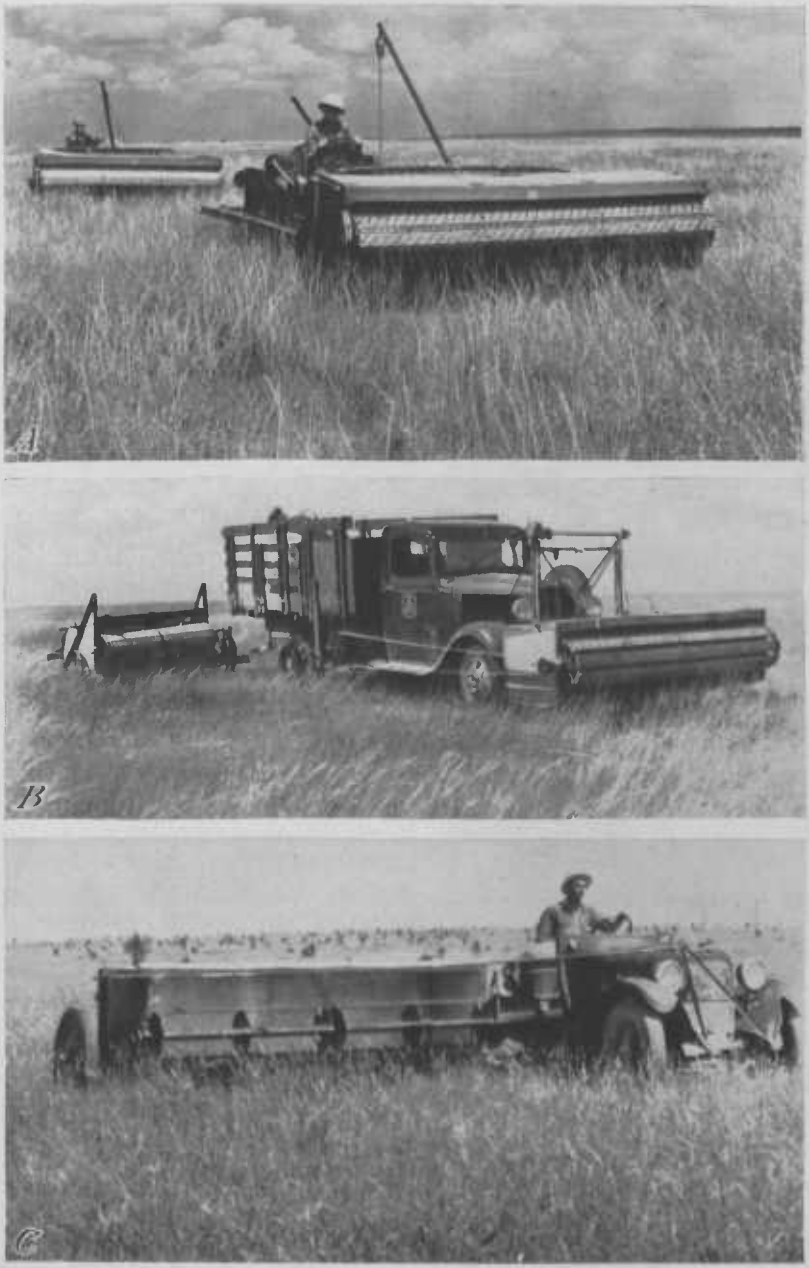


FIGURE 23.—Power strippers: *A*, Nebraska type operating in a native stand of grama and dropseed grasses. *B*, Improved Nebraska type, operating in a native stand of grama and dropseed grasses. Note the special features of height adjustment used for the spike-cylinder bluegrass stripper that is being trailed by the truck. *C*, Improved Arizona type, operating in a native stand of Rothrock grama.

quantity with this machine. The condition of the threshed seed depends largely upon the skill of the operator, but it is usually necessary for the seed to be run through a clipper fanning mill in order to clean it sufficiently for satisfactory use in ordinary farm drills.

The combine harvester has been used successfully in the collection of seed of big and little bluestem. Seed of very good quality was obtained, which required very little cleaning to prepare for farm seeding.

PROCESSING NATIVE GRASS SEED

The seeds of native grasses are very difficult to clean and prepare for seeding with standard farm equipment. The light, fluffy seed of certain species and the hairy glumes, sterile florets, and heavy awns of others present serious problems in the mechanical processing of the seed. As the seed material comes from the collection machines it is common to find a fairly large proportion of trash, straw, weed seed, and dirt that must be removed before the seed is suitable for seeding. These problems of seed cleaning have led to new uses of available seed-processing equipment as well as to the development of new machines that are better adapted to the specialized jobs of cleaning the seed of native grasses.

FIGURE 24.—Rubbing machine designed to remove awns and wings from light chaffy seed.

Thresher-separators of the type commonly used for threshing and cleaning small grains have been found satisfactory for the initial concentration of the seed of most native grasses. Careful adjustments of cylinder speed, screen size, and air volume must be made to meet the requirements of each species in order to prevent excessive losses of seed during the threshing operation. Practically any of the commercially available machines can be used if proper adjustments are made and careful machine operations followed. Pneumatic tires greatly facilitate the transportation of heavy equipment and permit the use of one thresher over a wide area. Machinery mounted on pneumatic tires has been found particularly useful in the threshing of native grass material that can be concentrated for threshing only at relatively isolated locations.

Although the procedures followed in harvesting the various species of native grasses differ widely, it has been found most economical to clean the seed after it comes from the thresher. In addition to the treatment afforded by the clipper type of fanning mill many species require also some form of mechanical scarification to remove persistent awns and glumes before the seed can be used most satisfactorily in the seeding machinery now in use on farms. Special methods of seed

scarification have been developed that show promise for use in the commercial handling of many of the native grasses.

In seeding certain native grasses the use of trashy seed material as it comes from the seed strippers and threshers without further cleaning appears to facilitate getting satisfactory stands. Little bluestem and sand bluestem have been successfully established by scattering overripe hay containing the seed on the area to be reseeded. The straw and trashy material improve the moisture conditions as well as offer additional protection to the seedlings during the critical period of early establishment and growth.

Several types of machines have been constructed to assist in the cleaning of certain species of grasses that cannot be treated satisfactorily with standard cleaning machines. A rubbing machine was constructed at the Tucson, Ariz., nursery for cleaning seeds of this type. It consists of a corrugated rubber apron that partly encloses a revolving cylinder in such a manner that tension can be applied to the seed flow that is fed into the machine between the revolving cylinder and apron. The rubbing effect produced by this operation is very effective in removing heavy awns and hairy, chaffy outer glumes of certain native grasses that cannot be cleaned with machinery that depends on size of screen for the separation of seeds. The capacity and efficiency of this rubbing machine (fig. 24) have been greatly increased by making both corrugated rubber surfaces movable at different speeds.

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